ON THE TREATMENT OF SLEEPLESSNESS AND PAIN.

6

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Two of the most important symptoms connected with the nervous system are sleeplessness and pain. It is proverbial that the longest way round is sometimes the shortest way home, and in discussing the treatment of sleeplessness, it may really be best to begin with the vital properties of a simple cell, such as an amœba or a leucocyte, consisting only of protoplasm surrounding a nucleus. This protoplasm sends out prolongations freely in all directions, and sometimes several cells meeting together may become fused in the form of a plasmodium. The activity of the protoplasmic movements varies with different conditions. They are accelerated by heat, they are retarded by cold, they are quickened by some foreign substances, and lessened or abolished by others. The same drugs which in minute quantities quicken their movements usually retard or abolish them in large doses, and, while moderate heat quickens movement, excessive heat abolishes it either temporarily or for ever. The waste products of tissue change in the cell itself, as they accumulate, lessen its movements and diminish its vitality. A mobile cell, like a leucocyte or amœba, can move away from the spot where its waste products have accumulated, just as a nomad moves his tent, but where cells are fixed the waste products must be removed from the cell, just as the refuse of cities must be carried away by a system of sewage while the inhabitants remain in their places.

Now, nerve cells, although in some respects the most highly developed of all those forming the tissues, are in other respects the most primitive, and this dual condition of a nerve cell is necessitated by the functions it has to fulfil, for its duties towards the organism are definite and permanent, and at the same time the external conditions under which the organism lives are constantly varying, and an extraordinary amount of mobility in the nerve cell is required to meet them. We find, then, that a nerve cell has two kinds of connection:—(1) a definite prolongation, or nerve, which undergoes no very evident change during its functional activity, and (2) numerous protoplasmic processes by which connections with other nerve cells may be established in ways which are so varied that, when we consider the number of cells in the nerve centres, the variations may be looked upon as infinite. It is now generally assumed that the connection between the nerve cells in the centres is affected by their protoplasmic prolongations. When these are in touch the nervous force may pass from cell to another, but when these are withdrawn from one another the nervous current is at once cut off, just as an electric current is broken by turning a switch and disconnecting the ends of the wire through which the current ought to pass. Such an explanation appears to fit in well with many commonly observed facts, such as that of sudden loss of memory for a name, and its sudden return when one is not thinking of it. The loss is explained by the retraction of the amœboid prolongations, so that the current of memory is broken and its re-establishment is effected by the extension of the prolongations, so that they again touch. In old age the prolongations become fewer and less mobile, so that the mental faculties become more limited and more sluggish. Like the leucocyte or amœba, the functions of the nerve cells can be greatly influenced, either by the products of their own waste, or by the products of tissue metabolism in other parts of the body. There is a natural process of self-regulation in the body, by which periods of activity alternate with rest. During the activity of the nerve cells, their waste products accumulate and tend gradually to diminish the functional activity of the cell, until at last it becomes inactive. During the period of rest, these waste products are either removed or undergo a process of change, whereby their physiological action is altered from a stimulating to an exciting one, just as the narcotic principle of the poppy, morphine, may be converted into a strychnine-like substance, by a simple chemical alteration.

The products of nervous waste are removed by the blood and lymph which circulate through the brain, and these also supply new material to repair the waste of the nerve cells and oxygen to maintain their functional activity. During sleep, the protoplasmic processes of those cells which keep up connection with the outer world, are so much withdrawn from each other that this connection is broken, while the cells connected with the vital processes of respiration and circulation continue their work uninterruptedly, and sometimes the cells connected with thoughts and ideas may also be functionally active, as evidenced by dreams. We cannot, as yet, localize these cells anatomically. We may suspect that they are the links between the cerebrum and the basal ganglia, but this is no more than a suspicion, and at present we can only class them more or less vaguely according to their function. The functional activity of the cells which maintain communication between thoughts or ideas and the external world may be excited, and this communication which has been broken by sleep may be at once restored by powerful stimulation from without, by a loud noise sounding in the ears, a bright flash of light thrown upon the eyes, or an unwonted or painful stimulus to the surface of the body. All such stimuli tend to maintain the connection between the outer world and the sensory nervous centres, and thus either to awaken from sleep or to prevent sleep from occurring; but stimuli coming from other parts of the nerve centres may have a similar effect to those coming from without, and painful ideas, anxiety or even pleasurable excitement may keep up the communication with the outer world and prevent sleep.

Functional activity of the nerve cells is usually associated with a more rapid flow of arterial blood through the brain, and it has been observed by Durham and others that the cerebral arteries dilate at the moment of awakening, while during sleep they become contracted, and the circulation through them diminished. In coma, the condition of the circulation which obtains in sleep is still further accentuated, so that while the arteries become very contracted the veins become much dilated and engorged, just as we see in the hands that the first effect of cold is to cause paleness, but later on it produces venous engorgement with blueness. Usually, the circulation of arterial blood through the brain is regulated by the contractile power of the arteries, but when arterial blood flows to the brain in large quantity, and under high pressure, sleep is more difficult of attainment. For example, when the carotid arteries become atheromatous, and thus lose their contractility, insomnia is apt to become a very distressing symptom, and the same thing occurs in cases of gouty kidney, where the high arterial tension drives the blood forcibly through the brain. External stimuli not only act reflexly upon the tissue change in the nerve cells, but they tend to cause contraction of arterioles in the body generally, and thus raise the arterial tension. Thus, if the feet are too cold, if the feet are too hot, or if there be any peripheral irritation, painful or even uncomfortable, the tension will rise, and sleep be interfered with. But the tension may be increased from the heart as well as from the vessels, and anything that stimulates the heart to excessive action will raise the tension, and consequently interfere with sleep. Irritation of the stomach by undigested food, by food that is too hot, by excessive acidity, by tobacco, tea, coffee or other drugs, will raise the arterial pressure and interfere with sleep. The effect of blood pressure on the brain upon the states of sleeping and waking was well shown by Friedländer. After giving an animal a arge dose of isoporopylic alcohol, he found that he could determine the condition of sleeping or waking by altering its position. If it were held up by the legs, so as to increase the supply of blood to the head, it at once awoke, but when held up by the ears it fell asleep.

In treating insomnia, we have then first of all to consider the remedies which bear upon the circulation. Where the arteries are atheromatous, we must restore their contractility, if possible, by means of iodide of potassium and of massage, and this method is sometimes very efficacious. Under it I have seen the carotids of an elderly lady, which previously appeared to be as hard and rigid as tobacco-pipe stems, become comparatively soft and elastic, whilst the patient regained, to a corresponding extent, the power to sleep which she had lost. Where the arterial tension is very high, as in cases of arterio-scleroses or contracting kidney, the high frequency current is sometimes useful, by lowering the blood pressure.

We must remove sources of local irritation, relieve pain if it be present, warm the feet or other parts of the body by hot bags or bottles, if necessary, or else by friction. In cases where indigestion produces insomnia, we should give no food during four hours or more before sleeping time, or, if this is found to be disadvantageous, the food should be of the lightest description. Where flatulence and acidity prevents sleep, some bicarbonate of soda and peppermint is sometimes more efficacious than a sleeping draught. Occasionally, when the whole body gets too hot and the circulation excited, merely getting out of bed and walking a few times round the room to get cool will allow the patient to obtain sleep. When the skin is uncomfortable from dryness, want of elasticity or the presence of waste products, a hot bath or hot sponging, followed by very gentle drying, will sometimes bring on sleep. Where the feet are persistently cold and not relieved even by a hot bag, putting them in cold water, rubbing them hard until they are red, then drying with a warm soft towel, may relieve. The splanchnic area is able to contain a large quantity of blood, and one may sometimes, as it were, bleed into this area, and lessen the circulation in the brain by dilating the vessels of the intestine and stomach. This may be done by the external application of a hot bag to the abdomen, or, still better, by a wet compress, or by the introduction into the stomach of a little bland, warm food, such as gruel or soup. When patients awake in the middle of the night and cannot get to sleep again, this food may be kept warm at their bedside during the night, so as to be ready at the proper moment, by placing it in a baby's food-warmer. If the food is too hot it tends to excite the heart, which is only divided from the stomach by the diaphragm, and the local heat passing through and stimulating the heart directly will raise the arterial pressure, and undo the good that might be otherwise obtained by dilating the vessels of the stomach.

Where the action of the heart is kept up by a high temperature, as in fevers, sponging the skin with hot water, dabbing it afterwards with a soft napkin and leaving the patient's body exposed under a cradle, with only one blanket over it, will lower the temperature and bring on sleep. In place of this, antipyretics, such as phenacotin, antipyrin, etc., will sometimes act as hypnotics when more purely narcotic substances entirely fail. Chloral hydrate, by its depressing action upon the heart, combined with its sedative action on the nerve cells themselves, is a powerful hypnotic, either alone or combined with others, and where the tension is high may be more successful than others which act only upon the nerve cells.

We must now pass on from the circulation to consider the effect of drugs upon the nerve cells. Some of them appear to increase the power of the cells to put forth protoplasmic prolongations, while others lessen or abolish it.

Amongst those which increase the power of the cells to put forth protoplasmic prolongations, or perhaps to prevent their retraction, the most powerful appear to be certain substances nearly allied to uric acid, and belonging to the so-called xanthin group. These are the active principles of tea, coffee, cocoa and Paraguay tea, etc. In many people tea or coffee tends to produce great wakefulness, so that they may either lie quiet in comparative comfort or toss about without any apparent reason, and in all such cases it is well for the patient to avoid taking tea or coffee for a good many hours before going to bed. Some people, indeed, are so sensitive that it is unsafe for them to take it later than breakfast time.

Perhaps, in place of drugs, I ought to say chemical substances, for lactic acid, which is a product of muscular waste, appears, according to Preyer, to have a considerble power to lessen cerebral activity and produce sleep without exerting any marked influence upon the circulation. The most abundant nitrogenous product of muscular waste is urea. This, when pure, does not seem to act as a soporific, but some bodies allied to it in chemical composition are powerful and useful hypnotics. The first of those to be introduced was urethane, or perhaps ought rather to say urethanes, which are compounds of various alcohols with urea. The one to which the name of urethane is given is a compound of ordinary ethyl-alcohol with urea. Another, hedonal, contains methyl and propyl-alcohols, while one lately introduced, veronal, which is diethyl-malonyl-urea, appears to be the most efficacious of this group hitherto introduced into practice, and in doses of 7 to 15 grains it appears to produce refreshing sleep. It is quite possible that bodies belonging to this group are formed in the muscles or glands during their functional activity, and that they may play an important part in inducing natural sleep after muscular fatigue. As long ago as 1839, Dr. Perey showed that in all probability alcohol has a peculiar affinity for the cerebral substances, as a much larger proportion could be recovered from the brains of animals poisoned by it than from their other organs. In the compounds of which I have spoken, it is not improbable that the alcohol may form a link which binds the urea to the nerve substance.

Alcohol itself is sometimes a powerful hypnotic, partly by drawing blood to the stomach, and partly by its sedative effect upon the nervous structures themselves. One of the first fruits of the recognition of the relationship between chemical constitution and physiological action was the introduction of chloral by Liebreich. This body contains more oxygen than ordinary alcohol, and also contains chlorine. By its double action in enfeebling the heart and thus lowering the blood pressure, while at the same time lessening the functional activity of the nerve cells, it is a powerful hypnotic. It has fallen of late years into comparative disuse, on account of the dread of its weakening the heart, but in cases of high tension, as in chronic Bright's disease, its power of lowering the blood pressure makes it very useful. Three other bodies, in which sulphur is combined with alcoholic radicals, are sulphonal, trional and tetronal. The tetronal seems to be the least useful, and trional now the most useful. They usually produce sleep without any bad effects, but I have seen the administration of a dose of sulphonal followed for a few hours by marked symptoms of disseminated sclerosis. The bromides appear not only to lessen the excitability of those nerve cells which bring the inner consciousness into relationship with the external world, but to depress nervous excitability generally. They are therefore exceedingly useful in many cases, not only in aiding sleep, but in diminishing general irritability of various kinds, and in combination with other drugs, such as chloral, trional and veronal, or with a more powerful narcotic, such as opium, they are most useful. Valerian is another substance which lessens excitability, and although its mode of action is practically unknown to us, its utility in the excitable conditions known as hysterical is unquestioned. It has no power to compel sleep, but sometimes, when given at night, by lessening nervous irritability, it may induce sleep. The more powerful narcotics, such as opium and its alkaloids, cannabis-indica, hyocyamus and hyoscine have a double action, namely, they tend to relieve pain as well as to induce sleep.

One of the great advantages of morphine and hyoscine is that they can be so readily administered subcutaneously, and thus they are rapidly absorbed, and their action is obtained quickly and certainly. We do not exactly know where the sensory centre for pain is situated in the brain, but we know that painful impressions are probably conveyed, to a great extent at least, by the grey matter, or perhaps by Gowers's tracts in the spinal cord, and usually originate in some severe stimulus being applied to peripheral nerves. Though it is the application of such a stimulus that generally gives rise to pain, yet pain may be produced by irritation of nerve trunks, of the spinal cord itself or of the cerebral centre, although there may be no peripheral cause. Thus, in so-called hysteria, pain has been felt in the joints so severe and so persistent as to lead to the limb being amputated, although the joint was perfectly healthy, and no cause for the pain could be assigned except a mental impression on the part of the patient to which the name of "hysterical" is applied. There can be no doubt that not only is there a very great difference indeed between sensibility to pain in different individuals, but even in the same individual under different circumstances. A local injury which a man in health would scarcely heed or would indeed hardly feel may cause the same man, when broken down by illness, to feel the pain most acutely and express his feelings in terms which those around him think exaggerated. In trying to relieve pain, we must, if possible, remove the cause; for if we simply try to deaden the sensation we may do serious harm to the individual. Pain is nature's warning that something is going on which we ought to avoid. Therefore it is to a certain extent beneficial, but when the warning cannot be taken, when the pain continues, it is one of the greatest possible evils that man can experience, and death itself will be gladly welcomed in order to avoid it. Strong acids and strong alkalies will both destroy the tissues and act as caustics, but the pain produced by the two is very different; that of the alkalies being heavy and dull, while that of the acids is sharp and stinging. In testing the reflex action of the frog, no one thinks of using dilute caustic potash as an irritant to the foot, but uses dilute acid. When the acid is washed off and neutralized the irritation ceases. This observation may be very useful to us in practice. One of the commonest causes of severe pain is toothache, and this is very frequently indeed due to the irritation of an exposed nerve by acid substances or acid secretions in the mouth. If these be neutralized, the pain ceases in a marvellous manner, and I have found the prescription of my friend, Sir Dyce Duckworth, exceedingly useful. It consists of a little bicarbonate of soda with laudanum, put on a pledget of cotton wool and introduced into the decayed tooth. Sometimes a general aching of all the teeth is caused by the action of acid saliva upon the teeth just where they emerge from the gums, and this may be relieved or cured by frequently washing the mouth out with a solution of bicarbonate of soda or sucking tabloids of the same substance.

In a paper which I read before the British Medical Association three years ago, I mentioned that increased sensibility to pain may sometimes be due to lessened alkalinity of the blood, and that the administration of alkalies may thus tend to relieve it. The severe pain of gastric or duodenal ulcer may be relieved almost certainly by large doses of an alkali, but as these may tend to soften the tissues of the ulcer and increase the liability to hæmorrhage, I usually give along with bicarbonate of soda a little chalk to act as an astringent to the tissues, and some carbonate of magnesia to counteract the constipating effect of the chalk. In renal pain, especially where a calculus is present in the pelvis of the kidney, and where the urine at the same time is excessively acid, I think we get relief of the same kind by lessening the acidity of the urine by alkaline bicarbonates, citrates or tartrates. Pressure upon peripheral nerves, especially when their excitability is increased by inflammation, produces intense pain, and this may frequently be relieved by fomentations, poultices or compresses, which soften the tissues and thus lessen pressure. These same applications to the abdomen relieve pain, though here their action is probably due, in part at least, to their effect in producing more even and gentle peristaltic movement, with relaxation of spasm to the muscular fibres. In the pain of joints a similar relief may sometimes be experienced from their use, but when inflammation has taken place under some unyielding structure like a tense fascia or in bone, the application of heat, instead of relieving pain, tends to increase it, because the heat dilates the vessels of the part, which thus press more powerfully upon the nerve fibres and intensify the pain. In such cases, icebags do more good than hot poultices, and in the case of a tooth, where the pain is due to inflammation in the alveolus, cold to the cheek may relieve a good deal more than warmth, although warmth to other parts may ease the patient by drawing blood away from the tooth. A large number of drugs, belonging to the aromatic group, have a powerful action, as analgesics, salicylate of soda, antipyrin, phenacetin, exalgin, phenalgin, &c.

We do not quite know the *modus operandi* of these drugs, but it would almost seem as if they diffused the painful impression in the spinal cord, so that it no longer reaches the sensorium. Where, however, the impression is so very extreme that it reaches the sensorium in spite of the action of these drugs, they may appear to intensify rather than relieve it. This is not very common, but I have seen cases in which it seemed to occur. Where the pain is due to irritation in the cord itself, these drugs appear to be more powerful than morphine or opium, but the most general of all analgesics are certainly opium and its alkaloids. They are frequently applied locally to painful parts before the fomentations, but it is questionable how far such fomentations are any better than those made of plain hot water. It is after absorption, and after it has reached the nerve centres, that opium or its alkaloid, morphine, acts. In most cases all the benefits which opium can confer may be obtained by the use of morphine, and this has the great advantage, as already mentioned, that it may be given subcutaneously and its rapid action thus ensured, but apparently this is not always the case, and sometimes opium suits better than morphine.

I have found that a most useful way of giving opium consists in mixing half a drachm to a drachm of tincture of opium or liquid extract of opium, with enough water to bring it up to two fluid drachms, and inject it into the empty rectum by a glycerine syringe. In half-an-hour to three-quarters the opium is usually absorbed, and I think relieves pain almost more efficiently and for a longer time than a subcutaneous injection of morphine will do. This method of administration has the advantage over that of the stomach, that the opium comes in contact at once with mucous membranes, and is not diluted by other substances, whereas in the stomach there may be a large quantity of food which interferes with absorption. Some of the most severe pains in the body are due to combined spasm and distension of hollow muscular organs, *e.g.*, of the stomach and intestines by flatulence, of the bladder by urine, of the biliary ducts or ureters by calculi, of the heart and aorta by high arterial pressure in angina pectoris, and in simple headache to spasm of the vessels. In all these cases, if the pain be very intense, opium or morphine may be required for its relief, and sometimes, as, for example, in biliary colic, I have seen pain so intense as to resist the action of morphine injected subcutaneously in large doses. In such cases, a plan suggested by the late Mr. Morrant Baker is sometimes most useful. A few whiffs of chloroform are given, just enough to put the patient under. The chloroform anæsthesia passes into the opium narcosis, and the patient will sleep for hours unconscious of pain. In the case of angina pectoris, the lowering of the tension by vascular dilators, such as nitrate of amyl, nitro-glycerine or nitro-erythrol, generally relieve the pain at the time, and its recurrence may be to a great extent lessened by reducing the tension generally through a diet containing but little nitrogen, and by the continuous use of nitro-erythrol or other vascular dilators. One of the newest of those which seems to promise much is the hippurates of soda or of ammonia introduced by Dr. George Oliver. The pain of headache is, I feel sure, from very many observations in my own person, due to what one might term a colic of the arteries in the head, there being peripheral contraction and central dilatation. The quickest way of relieving this is usually by the use of such substances as antipyrin or phenacetin, and their action is rendered more efficacious by the combination of those drugs with small quantities of citrate of caffein. I have found that headaches can usually be not only arrested, but prevented, by a more or less continuous use ot bromide of potassium and salicylate of soda, combined with some aromatic spirit of ammonia to avoid depression. There are some headaches where these remedies are of little use, *e.g.*, the nocturnal headaches associated with specific disease, and in them large doses of iodide of potassium are most useful. Occasionally, this drug renders most signal service even when no history of specific disease can be obtained, and in cases where there is much tenderness of the scalp, benzoate of soda, which is nearly allied in its chemical constitution to salicylate, may relieve the pain while the salicylate is powerless.

I had intended to say more about the use of electricity and massage in the treatment of sleeplessness and pain, but I have already somewhat exceeded the limits allowed me, and would only remark in conclusion that, comparing our present means of ensuring sleep and relieving pain with what they were thirty or forty years ago, we have great cause for congratulation and great hope for the future.